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(19)

(54) IMPROVEMENTS IN OR RELATING TO CONSTANT VELOCITY UNIVERSAL JOINTS

(71) We, GKN TRANSMISSIONS LIMITED, formerly GKN Birfield Transmissions Limited, a British Company of P.O. Box 405, Chester Road, Erdington, Birmingham 24, in the County of Warwick, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to constant velocity universal joints.

By a constant velocity universal joint we mean a joint in which the angular velocity of the driven member is constant when the driving member is rotated at a constant angular velocity throughout the range of relative angular movements permitted by the joint between the axes of the driving and driven members, i.e. the velocity ratio is constant.

In particular the invention is concerned with a constant velocity universal joint of the kind including the inner member adapted to be connected to either a driving shaft or a driven shaft, an outer member surrounding the inner member and adapted to be connected to either a driven shaft or a driving shaft, registering tracks formed respectively externally on the inner member and internally on the outer member, each pair of registering tracks being adapted to receive a torque transmitting element, normally a ball, and means being provided for assisting in maintaining the torque transmitting elements in the bisector plane of the joint when relative angular movement occurs between the axes of the inner and outer members. Such a joint is hereinafter referred to as "a constant velocity universal joint of the kind specified."

Constant velocity universal joints of the kind specified have heretofore had a principal application in connection with front wheel drive vehicles and such joints are relatively expensive, for it has been the practice to provide the tracks in both the outer and the inner members by milling and grinding operations and this, particularly in the case of the formation of internal tracks on the outer member, is a somewhat expensive operation.

Furthermore in the case of a transmission drive shaft for a rear wheel drive vehicle it is the practice to use Hooke's joints which do not provide for transmission of constant velocity ratio drive between the driving and driven shafts, because of the cost factor advantage as between such a joint and a constant velocity universal joint of the kind specified.

During recent years constant velocity universal joints of the kind specified have been designed so as to provide not only for relative angular movement between the driven and driving members of the joint but also for relative axial movement between said members, such joints being known as plunging constant velocity joints of the kind specified, and, but for the aforementioned cost factor, these joints could have a very wide application since their inherent axial plunge feature enables one to eliminate the spline coupling which has heretofore been an essential feature of transmission drive installations notwithstanding the disadvantage of high axial loads under torque inherent in such couplings.

It is an object of the present invention to provide an improved construction of a constant velocity universal joint of the kind specified which can be made more cheaply than heretofore and which will be commercially viable for a wider range of transmission drive applications than heretofore.

According to a first aspect of the invention we provide a constant velocity universal joint of the kind specified wherein the outer member of the joint is constituted by an end portion of a tubular metal element which constitutes either the driving shaft or the driven shaft of the joint, said end portion of the tubular element having a wall

thickness which is greater than that of the main portion of the tubular element and being "formed" (as herein defined) to define the torque-transmitting element-receiving tracks of the outer member of the joint.

The expression "formed" as used herein means the treatment of metal by way of a pressing, extruding, swaging or other operation which shapes the metal but which does not involve the removal of any metal as by a cutting, grinding or like machining operation.

By making the outer member of the joint integral with its associated shaft the expense of connecting the shaft to the outer member is avoided. By making the end portion of the tubular element of greater wall thickness than the remainder of the tubular element, said end portion can be made sufficiently strong for load-carrying purposes without it being necessary for the whole of the element to be of this wall thickness, thus reducing the cost of the tubular element. By "forming" the tracks as opposed to producing them by an operation involving removal of metal, the cost of the joint is still further reduced.

The tubular element may be a propellor shaft.

According to a second aspect of the invention we provide a method of manufacturing a constant velocity joint of the kind specified wherein the outer member of the joint is constituted by an end portion of a tubular metal element which constitutes either the driving shaft or the driven shaft of the joint, said method including operating on the tubular element so that said end portion thereof has a wall thickness which is greater than that of the main portion of the tubular element, and "forming" (as herein defined) said end portion to define the torque-transmitting element-receiving tracks of the outer member of the joint.

The invention will now be described by way of example with reference to the accompanying drawings, wherein:—

FIGURE 1 is a longitudinal sectional view of one form of plunging constant velocity universal joint of the kind specified embodying the invention, and

FIGURE 2 is a section taken transversely to Figure 1, the section of Figure 1 being taken along the line 1—1 of Figure 2.

The plunging constant velocity universal joint illustrated in the drawings includes an inner member 10 which is provided with straight longitudinally extending ball-receiving tracks 11. The inner member 10 is splined on to a shaft 12 and retained thereon by a circlip 13 or like securing ring, the shaft 12 having a flange 14 whereby it can be connected to, say, an output member from the gear box of a vehicle.

The joint also has an outer member 15 which is integral with a tubular propeller shaft 16. The propeller shaft and outer member are formed from a tubular metal element which is upset so as to increase the wall thickness of the end portion thereof. After the upsetting operation, the thickened end portion of the element is subjected to a suitable "forming" operation so as to form therein six straight longitudinally extending ball-receiving tracks 17, Figure 2, the "forming" operation being such that the internal surfaces 18 between adjacent tracks 17 are all part of a common cylindrical surface so as to provide a cylindrical bearing surface for the outer face of a ball retaining cage 19.

Prior to the "forming" operation a closure plate 20 is inserted in the end of the tubular element and is fixed in position so as to close the inner end of the bore defined by the outer member 15.

Although not illustrated in the drawings it is envisaged that the closure plate 20 may have a central domed portion which projects towards the shaft 12 to limit axial movement of the inner member 10 toward the closure plate by engagement with the end face 21 of the shaft 12.

During the same or, preferably, a subsequent "forming" operation the end of the end portion of the tubular element is plunged inwardly as shown at 22 so as to form a support for the one end of a seal or gaiter 23 which is substantially of Z-shape in section. The said one end of the seal or gaiter is retained in engagement with the inwardly plunged end 22 of the tubular element by means of an internal clip or ring 24 and the other end thereof is retained on the shaft 12 which carries the inner member 10, by means of an externally mounted ring or clip 25.

As will be observed from reference to Figure 1, the ball carrying cage 19 is such that the inner surface 27 thereof is of part-spherical form being struck about a centre 28 which is off-set to one side of the joint centre 29, whilst the outer surface of the cage includes a part-spherical portion 30 struck about a centre 31 which is offset by an equal amount to the other side of the joint centre 29.

Such an arrangement, which is fully described and claimed in British Patent No. 1,072,144 ensures that, whilst there is freedom for relative axial movement between the inner and outer members 10 and 15 of the joint, the mating surfaces between the cage 19 and the inner member 10 and the cage 19 and the outer member 15 serve to maintain the torque-transmitting balls 20 positioned in the bisector plans of the joint throughout the whole range of permitted relative angular movement betwen the axes

of the inner and outer members 10 and 15, which positioning is of course a criterion for constant velocity ratio operation of the joint.

In "forming" the tracks 17 in the outer member 15, a one-part or multi-part mandrel having the required external contour will be positioned within the upset increased wall thickness end portion of the tubular element and the said portion will then be deformed inwardly so as to adopt the cross-sectional configuration shown in Figure 2. The provision of tracks 17 which are longitudinally straight facilitates removal of the mandrel subsequent to said inward deformation process. In an alternative arrangement, the upset increased wall thickness end portion is positioned within a die having the required internal contour and then said portion expanded electrohydraulically to the required cross-section.

The wall thickness of the tubular element from which the outer member 15 and propeller shaft 16 are made will normally lie originally within the range of from 2% to 16% of the tube diameter, depending on the diameter and on the intended use of the joint. The upsetting operation will normally be such that the increased wall thickness portion is approximately twice the wall thickness of the main portion of the tubular element.

It will normally be necessary for the tracks 17 which have been provided in the outer member 15 by the "forming" operation to be induction hardened.

The construction described above enables the outer member of a constant velocity universal joint and its associated propeller shaft to be formed very much more cheaply than heretofore and thus offers the possibility of a transmission drive unit with a plunging constant velocity universal joint of the kind specified at either one or both ends thereof forming a viable commercial alternative to the present arrangement wherein a Hooke's joint is provided at each end of the propeller shaft and there is an intermediate spline coupling.

Equally the invention can be applied to the formation of the outer member of a constant velocity universal joint of the kind specified which is not of the plunging type.

Furthermore, although the invention has been described in relation to its primary application in the vehicle transmission field it is capable of a wide application in the industrial field.

WHAT WE CLAIM IS:—

1. A constant velocity universal joint of the kind specified wherein the outer member of the joint is constituted by an end portion of a tubular metal element which constitutes either the driving shaft or the driven shaft of the joint, said end portion of the tubular element having a wall thickness which is greater than that of the main portion of the tubular element and being "formed" (as herein defined) to define the torque-transmitting element-receiving tracks of the outer member of the joint.

2. A constant velocity universal joint as claimed in Claim 1 wherein the torque-transmitting element-receiving tracks of both the inner and outer members of the joint are longitudinally straight tracks and the joint is a plunging constant velocity universal joint of the kind specified.

3. A constant velocity universal joint as claimed in Claim 1 or Claim 2 wherein a closure plate is fitted within the tubular element to close the inner end of the bore defined by the outer member of the joint.

4. A constant velocity universal joint as claimed in any one of the preceding claims wherein the end of said end portion of the tubular element is plunged inwardly so as to define a seating for a flexible seal which extends between the outer member and a shaft upon which the inner member of the joint is carried.

5. A constant velocity universal joint of the kind specified substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

6. A method of manufacturing a constant velocity universal joint of the kind specified wherein the outer member of the joint is constituted by an end portion of a tubular metal element which constitutes either the driving shaft or the driven shaft of the joint, said method including operating on the tubular element so that said end portion thereof has a wall thickness which is greater than that of the main portion of the tubular element, and "forming" (as herein defined) said end portion to define the torque-transmitting element-receiving tracks of the outer member of the joint.

7. A method as claimed in Claim 6 wherein said end portion of the tubular element is deformed inwardly in said "forming" operation.

8. A method as claimed in Claim 6 or Claim 7 wherein the end of said end portion of the tubular element is plunged inwardly so as to define a seating for a flexible seal to extend between the outer member and a shaft upon which the inner member of the joint is carried.

9. A method of manufacturing a constant velocity universal joint of the kind specified substantially as herein before described.

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1 SHEET This drawing is a reproduction of the Original on a reduced scale

Fig. 1

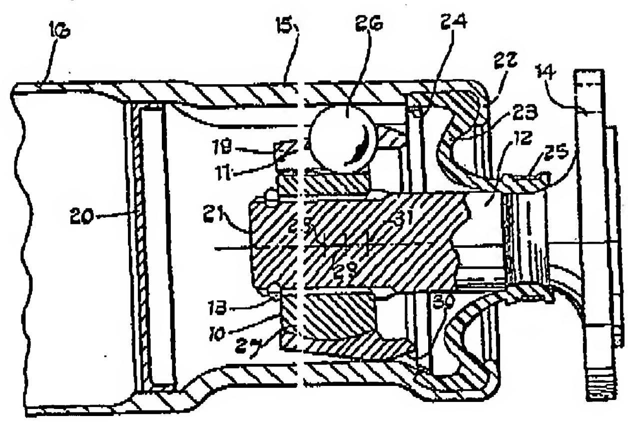

Fig. 2